

This appendix provides information to the designer on determining contract time.

DETERMINATION OF CONTRACT TIME

I. Background

- A. Contract time is the maximum time allowed in the contract for completion of all work contained in the contract documents. Contract time often arises as an issue when the traveling public is being inconvenienced and the contractor does not appear to be aggressively pursuing the work. There may be a number of reasons for a project to appear dormant, such as weather limitation, concrete curing times, materials arriving late, etc. However, all too often the causes are traceable to excessive time originally established by the contracting agency to complete the project or poor contractor scheduling of construction operations.
- B. The duration of highway construction projects in many instances is more critical today than it was in the past. Several of the reasons are listed below:
 - 1. Traffic volumes on most highways are generally continuing to increase. This is creating a greater impact on the motoring public in both safety considerations and costs.
 - 2. Proper selection of contract time allows for optimizing construction engineering costs and other resources.

II. Elements in Determining Contract Time

- A. Written procedures for the determination of contract time are important so that production rates and other considerations are applied uniformly throughout the State. These procedures should account for significant geographic, and climatic differences throughout the State, which could affect contractor productivity rates. The fact that some types of work can be undertaken during certain times of the year while other types of work cannot, should be addressed. Where applicable, the affect of working under traffic also needs to be considered.
- B. The reasonableness of the contract time included in contracts is important. If time is insufficient, bid prices may be higher and there may be an unusual number of time overruns and contractor claims. If, on the other hand, the time allowed is excessive, there may be inefficiencies (costs) by both the State and the contractor. Also, the public may be inconvenienced unnecessarily and subjected to traveling on roadway where safety is less than desirable for an extended period of time. In establishing contract time the State should strive for the shortest practical traffic interruptions to the road user. If the time set is such that all work on a project may be stopped for an extended period (not including necessary winter shutdowns) and the contractor can still

complete the project on schedule, it means the contract time allowed was excessive. (There may be some exceptions as indicated in “Factors Which Influence Contract Time”) and “Other Factors Which Influencing Contract Time.)”

C. For most projects, the essential elements in determining contract time are:

1. Establishing production rates for each controlling item,
2. Adapting production rates to a particular project, and
3. Computation of contract time with a progress schedule.

EXPERIENCE AND JUDGMENT SHOULD BE USED IN THE FINAL DETERMINATION OF CONTRACT TIME.

III. Establishing Production Rates

A. A production rate is the amount or quantity produced/constructed over a specific time period. The application of realistic production rates is the key in setting an appropriate contract completion time. Production rates for the same item of work will vary considerably across the State, from small to large construction projects and from rural to urban areas. Production rate ranges should be established based on project size, type (grading, structures, etc.), and location (urban or rural) for controlling items of work.

B. Typical production rates follow this text.

IV. Factors Which Influence Contract Time

A. In addition to production rates, the following items should be considered when determining contract time:

1. Effects of maintenance of traffic requirements on scheduling and the sequence of operations.
2. Curing time and waiting periods between successive paving courses or between concrete placement operations, as well as specified embankment settlement periods.
3. Seasonal limitations for certain items needs to be considered when determining both the number of days the contractor will be able to work as well as production rates.,
4. Conflicting operations of adjacent projects, both public and private.
5. Review time for falsework plans, shop drawings, post-tensioning plans, mix designs, etc.
6. Time for fabrication of structural steel and other specialty items.

7. Time for fabrication/procurement of signal/illumination equipment.
 8. Coordination with utilities.
 9. Time to obtain permits.
 10. The effects of permit conditions and/or restrictions.
 11. Restrictions for nighttime and weekend operations.
 12. Time of the year of the letting as well as duration of the project.
 13. Special local area events (i.e. Parades, Festivals, Athletics, Fairs, and Races).
 14. Canadian and neighboring states holidays.
 15. Location.
 16. Work hour/noise restrictions.
 17. Other pertinent items as determined by the designer.
- B. Zero working days may be indicated during the winter months while 20 to 22 working days per month are common during the summer. Bridge work is generally assigned the greatest number of working days per month. If historical working day data is not available, historical rain and temperature data is available from the National Weather Service to develop average working days per month.

V. Adapting Production Rates to a Particular Project

- A. Before time durations for individual work items can be computed, certain project specific information should be determined and some management decisions made. A determination should be made relative to the urgency of the completion of the proposed project. The traffic volumes affected as well as the effect of detours should be analyzed. The size and location of the project should be reviewed as well as the effects of staging, working double shifts, the feasibility of night work as well as restrictions on closing lanes. Also, the availability of material for controlling items of work should be investigated. For example, it might be appropriate to consider the need for multiple crews on a specific item to expedite the completion when there are exceptionally large quantities or when there is a large impact on traffic.
- B. Procedures which would accelerate project completion should be considered when construction will affect traffic substantially or when project completion is crucial. This is especially important in urban areas which have high traffic volumes. Realizing that public inconvenience needs to be minimized, the production rates applied in setting the contract time for these types of projects should be based on that of an efficient contractor working more than 8 hours per day, more than 5 days per week, and possibly

with additional workers. The development and application of a separate set of production rates for these critical types of projects is recommended.

VI. Computation of Contract Time - Developing a Progress Schedule

- A. The contract time for most construction projects can be determined by developing a progress schedule. The progress schedule basically shows the production durations associated with the chosen production rates for the items of work. The time to complete each critical item (critical items are those items that are essential to the total project completion) of work included in the progress schedule is computed based on the production rates applicable to that project. Critical items should be arranged by chronological sequence of construction operations. Minor items that may be performed concurrently with critical items do not need to be analyzed.
- B. In determining a progress schedule it should be remembered that the start and ending time for each critical item needs to be based on the earliest time on which work on that item will begin and how long it will take to complete. The earliest start time for each activity will be determined by the completion of the activities which precede it, allowing for the fact that some activities can begin before the preceding activity is entirely completed. Along with the time established for all critical items, additional time should be allowed in the contract for initial mobilization.

VII. Critical Path Method

- A. The critical path method (CPM) must be used to determine the number of working days. The CPM used to determine working days for a project shall be transmitted to the Plans Branch with the PS&E transmittal.
- B. A brief description of the application of the CPM technique to determine contract time is indicated below:
 - 1. The first step in applying the CPM method is to break a project down into separate tasks or operations necessary for project completion. Each of these separate operations or processes is called an activity. The completion of an activity is called an event.
 - 2. Once all the activities necessary to complete a project have been listed, the relationship of these activities to one another needs to be determined. In some cases several activities can be undertaken concurrently while at other times certain activities cannot be undertaken until others have been completed. In general, in determining the sequence of operations, the question needs to be asked: "What needs to be done before proceeding with this activity as well as what can be done concurrently?" Every activity, therefore, has a definite event to mark its relationship with others with respect to completing a project.
 - 3. In working with this procedure, a network, which is a diagrammatic representation of the project to be undertaken, is developed. The network

shows the correct sequence and relationship to activities and events. Each separate activity is shown by its own arrow and the start of all activities leaving a node depends on the completion of all activities entering a node. Therefore, the event represented by any node is not achieved until all activities leading to the node have been completed. The resulting diagram will be schematic representation of a project, showing all the relevant activities and events in correct sequence.

4. An actual time can be set to each activity based on production rates and other appropriate factors. The time to complete each activity is shown on each arrow to indicate the duration. The "early start" for each activity is the earliest point in time that it will start, provided that all activities before it have finished. This is not necessarily the point in time that it will start; however, it is the earliest time that it can start. The "early finish" for an activity is merely the duration of the activity after its "early start". As is the case with the "early start", this is not necessarily the point in time that the work represented by the activity will be over, but is the earliest point in time that it can occur. A "finish" date in CPM is defined as the first day upon which no further work is to be done for an activity; it is the first day after the physical completion of the activity. The completion time of a project is, therefore, the sum of the longest time path through the network leading to completion of the project.
5. The optimum time and cost for performing the project can be evaluated by assigning resources (equipment, labor hours, and materials) to each activity. The diagrammatic representation of the project then provides a means to evaluate the costs incurred with respect to the completion of specified activities.

C. This brief summary gives an indication of how this method can be applied to each project. Several advantages of using such a schedule are:

1. It is an accurate technique for determining contract time and verifying that the project can be constructed as designed and with identified construction sequences:
2. It is a useful tool for project managers in monitoring a project, especially when dealing with relationships of work items with respect to time; and
3. Activities responsible for delays can be identified and corrective measures to keep a project on schedule can be determined.

D. Several drawbacks of CPM schedules are:

1. They need to be developed by someone knowledgeable in using CPM scheduling; and

2. They need to be updated regularly to assure that the contractor's operation is accurately represented.

E. Two classes, offered by the Department, for design scheduling are listed below:

- CB5** GEN: Intro to Scheduling
 - See ATMS for course description
- CIL** DES: Contract Working Days Requires CB5
 - See ATMS for course description

Courses may change so the designer should always check with their Region Trainer for latest courses offered.

VIII. Other Factors Which Influence Contract Time

- A. Construction time on some projects, such as illumination or signalization, may be governed by the long lead time necessary to obtain materials. To minimize traffic disruption, the contract may specify a completion date several months after the notice to proceed, but the contractor should be limited to a relatively short on-site time. This may be accomplished by including in the contract a "conditional notice to proceed" clause which would allow a specified amount of time to purchase and assemble materials followed by issuance of a full work order which would be issued upon expiration of the assembly period or sooner, upon the contractor's request.
- B. Another approach in which greater flexibility may be allowed would be to include in the contract a combination of an overall completion date and a specified number of consecutive available working days which would be charged once construction had started. It is sometimes advantageous to allow a contractor to set the actual construction dates within a given construction season. An example would be a typical small paving job that may only require the contractor to be on-site for a few weeks. For a project let in the spring, the completion date can be set for the end of the construction season, but the contractor's on-site time may be limited in the contract to a month. This allows the contractor to schedule this contract with consideration of other work the contractor may have in the same paving season. Net benefits include lower project inspection cost and a minimal disruption to traffic.
- C. An option which may be applicable to some projects is dividing a project into phases with each phase having its own completion date. This may be applicable when coordinating with other projects or activities in the area in order to meet tight deadlines.

IX. Production Rate Table

The following production rates should be used in computing contract completion time. Production rates vary depending on amount of traffic, complexity of project or other restrictions.

Rates have been produced based on data furnished by districts with disregard to size or complexity of project or quantity of a particular item.

Generally, large quantities in a particular project will have high production rates.

PREPARATION

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Mobilization	Days	3 to 15	3 to 15
Clearing and Grubbing	Ac.	1.5	3
Stripping	Ac.	1.5	3.5
Removing Manhole	Ea.	2.5	2.5
Removing Catch Basin	Ea.	4.5	4.5
Removing Conc. Inlet	Ea.	6	6
Removing Bituminous Pavement	S.Y.	1,800	3,000
Removing Cement Conc. Pavement	S.Y.	600	1,200
Removing Asphalt Conc. Pavement	S.Y.	1,100	2,700
Removing Cem. Conc. Curb & Gutter	L. F.	1,100	1,500
Removing Asph. Conc. Curb	L. F.	1,900	1,900
Removing Cem. Conc. Sidewalk	S.Y.	250	730
Removing Guardrail	L. F.	1000	1,200
Removing Guardrail Anchor	Ea.	6.5	6.5
Removing Paint Line	L. F.	1,900	1,600
Removing Plastic Line	L. F.	900	500
Removing Paint Marking	S.Y.	320	60
Removing Plastic Marking	S.Y.	120	50
Removing Raised Pav't Markers	Hund.	8.5	3.0
Removing Chain Link Fence	L. F.	500	800
Removing Wire Fence	L. F.	2,100	2,700

Preparation Items

1. Clearing and grubbing rates are very dependent on density and type of vegetation.
2. Some of these items may be included in roadway excavation work.
3. If removal items are to be salvaged the production rate may be less.
4. Proximity of waste site may be a factor.

GRADING

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Roadway Excavation			
Range	C.Y.	600-16,000	1,000-12,000
Average	C.Y.	2,000	7,000
Pavement Repair Excavation	C.Y.	70-300	70-300
Borrow Excavation			
Range	C.Y.	850-2,500	1,700-12,000
Average	C.Y.	1,200	6,800
Embankment Compaction			
Range	C.Y.	850-7,500	1,500-12,000
Average	C.Y.	1,700	6,800
Gravel Borrow			
Range	Ton	1,300-4,000	900-17,500
Average	Ton	1,600	11,300

Grading items

1. Pavement repair excavation usually requires backfill and pavement replacement the same day.
2. Consideration must be given as to whether trucks or scrapers will be used.
3. Embankment compaction is usually in conjunction with roadway excavation or gravel borrow.
4. Rock cuts would decrease roadway excavation production rates.
5. Proximity of pit and waste sites may be a factor.

STOCKPILING (Aggregate Production)

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Ballast	Ton	1,200-3,000	1,200-3,000
Gravel Base	Ton	1,200-3,000	1,200-3,000
Crushed Surf. Base Course	Ton	1,200-3,000	1,200-3,000
Crushed Surf. Top Course	Ton	1,200-2,700	1,200-2,700

Stockpiling Item

1. Aggregate production is dependent on the source. Time must be allowed for drilling and blasting to get ahead of crushing operation in a quarry site.

DRAINAGE

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Ditch Channel Excavation			
Range	C.Y.	125-1,450	270-4,500
Average	C.Y.	950	1,700
Concrete Inlet	Ea.	4.5	4.5
Cement Conc. Gutter	L.F.	250-400	250-400
Asphalt Conc. Gutter	L. F.	600-1,000	600-1,000
Hand Placed Rip Rap	C.Y.	30-50	30-50
Riprap			
Range	Ton	350-1,550	350-1,550
Average	Ton	720	720
Quarry Spalls			
Range	Ton	250-1,000	250-1,000
Average	Ton	750	750
End Section W/Bars	Ea.	2.5	2.5
Flared End Section	Ea.	7.5	7.5
Underdrain Pipe			
Range	L. F.	200-700	200-700
Average	L. F.	300	300
Drain Pipe			
Range	L. F.	350-1,300	350-1,300
Average	L. F.	400	400
Culvert Pipe 12"-36"			
Range	L. F.	50-650	50-650
Average	L. F.	170	170
Culvert Pipe 42"-72"	L. F.	20-120	20-120
Stru. Plate Pipe	L. F.	20	20
Stru. Plate Pipe Arch	L. F.	20	20
Steel Under Pass	L. F.	20	20

Drainage Items

1. End sections are usually incidental to pipe runs.
2. Pipe production rates can vary due to depth of structure excavation.

STORM SEWERS

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Catch Basin Type 1	Ea.	3.5	3.5
Catch Basin Type 2 48"-54"	Ea.	2	2
Catch Basin Type 2 72"-96"	Ea.	1.5	1.5
Catch Basin Type 3	Ea.	2	2
Testing Storm Sewer Pipe			
Range	L. F.	675-3,500	675-3,500
Average	L. F.	825	825
Storm Sewer Pipe 12"-36"			
Range	L. F.	100-600	100-600
Average	L. F.	225	225
Storm Sewer Pipe 42"-72"	L. F.	50-200	50-200

Storm Sewer Items

1. Pipe production rates can vary due to depth of structure excavation.
2. Testing production rates are dependent on pipe sizes (large diameter pipe require more time then small diameter pipe).

SANITARY SEWER

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Testing Sewer Pipe			
Range	L. F.	750-3,500	750-3,500
Average	L. F.	925	925
Sewer Pipe 6"-48"	L. F.	125-400	125-400

Sanitary Sewer Items

1. Pipe production rates can vary due to depth of trench excavation.
2. Conflicts with existing utilities can cause reduced production rates.
3. Testing production rates are dependent on pipe sizes (large diameter pipe require more time then small diameter pipe).

WATER LINES

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Installing Valves	Ea.	3	3
Hydrant Assembly	Ea.	2	2
Resetting Hydrant	Ea.	1.5	1.5
Service Connection	Ea.	3.5	3.5
Water Main			
Range	L. F.	150-1,000	150-1,000
Average	L. F.	325	325

Water Line Items

1. Water main production rates can vary due to depth of excavation.
2. Time must be allowed for cleaning and testing.
3. Conflicts with existing utilities can cause reduced production rates.

STRUCTURE

See Chapter 12 for CONSTRUCTION TIME RATES in the *BRIDGE DESIGN MANUAL*.

SURFACING

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Ballast	Ton	1,000-3,000	1,000-3,000
Gravel Base	Ton	1,000-3,000	1,000-3,000
Crushed Surf. Base Course	Ton	1,000-3,000	1,000-3,000
Crushed Surf. Top Course	Ton	550-2,300	500-2,300

Surfacing Items

1. Shoulder work can reduce production rates.
2. Irregular areas can reduce production rates.

BITUMINOUS SURFACE TREATMENT

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Processing and Finishing			
Range	Mile	1-2.5	1-2.5
Average	Mile	2	2
Class A - 12' Wide			
Range	Mile	1.5-7.5	1.5-7.5
Average	Miles	5.5	5.5
Classes B,C,D - 12' Wide			
Range	Mile	2.5-10.5	2.5-10.5
Average	Mile	8.5	8.5

ASPHALT TREATED BASE

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Asphalt Treated Base	Ton	1,500-2,800	1,500-2,800

CEMENT CONCRETE PAVEMENT

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Cement Conc. Pavement	S.Y.	15,500	15,500
Unfinished Conc. Pavement			
	Range	S.Y.	1,300-25,000
	1,300-25,000		
	Average	S.Y.	4,500
	4,500		
Cement Conc. Approach	S.Y.	50-200	50-200
Bridge Approach Slab	C.Y.	40	40

Cement Concrete Pavement Items

- Concrete paving rates are based on a single drum batch plant. Single drum batch plant produces 10 CY per minute, with 90% efficiency.
- Concrete paving "Rule of Thumb" 1 mile of 24 foot wide pavement per day (slip form).

3. Unfinished concrete pavement usually has irregular areas that require more forming and hand work.
4. Allow time for forming, if required, and curing.
5. Cement Conc. Approaches are usually incidental to sidewalk work.

ASPHALT CONCRETE PAVEMENT

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Preparation of Untreated Roadway	Mile	1-4	1-4
Planing Bituminous Pavement			
Range	S.Y.	1,500-32,500	5,700-18,000
Average	S.Y.	3,200	9,800
Prime Coat Treatment	S.Y.	14,600	14,600
Asphalt Conc. For Prelevel			
Range	Ton	500-1,500	800-2,300
Average	Ton	700	1,500
Asphalt Conc. For Pavement	Ton	1,200-2,200	1,300-3,000
Asphalt Conc. For Shoulder			
Range	Ton	450-1,000	800-2,000
Average	Ton	800	1,200

Asphalt Concrete Pavement Items

1. Time may be required for road approaches.
2. Night work will affect paving production.
3. Requirements to plane and pave back in the same day will affect project time.

IRRIGATION AND WATER DISTRIBUTION

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Vacuum Breaker Assembly	Ea.	4.5	4.5
Manual Control Valve W/Box	Ea.	4.5	4.5
Auto Control Valve W/Box	Ea.	3	3
Auto Elec. Controller 5 or 8 sta.	E a.	1.5	1.5
Auto Elec. Controller 10 or 12 sta.	Ea.	1	1
Sprayer	Ea.	35	35
Sprinkler	Ea.	36	36

Irrigation/Water Pipe	L. F.	700	700
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EROSION CONTROL AND PLANTING

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Seed Fert. and Mulching			
Range	Ac.	4-10	4-10
Average	Ac.	8	8
Preparation For Planting .			
Range	S. Y.	1,600-7,000	1,600-7,000
Average	S. Y.	2,700	2,700
Sod Installation	S. Y.	800-2,750	800-2,750
Seeded Lawn Installation			
Range	S. Y.	2,000-18,000	2,000-18,000
Average	S. Y.	2,400	2,400
Mulch/Sawdust	C. Y.	360	360

TRAFFIC

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Cement Conc. Curb	L. F.	500	2,200
Beam Guardrail			
Range	L. F.	450-1,850	450-1,850
Average	L. F.	750	750
Beam Guardrail Anchor	Ea.	5.5	5.5
Precast Conc. Barrier	L. F.	750-1,600	750-1,600
Cast-In-Place Barrier	L. F.	100-800	100-800
Temp. Conc. Barrier	L. F.	800-1,800	800-1,800
Resetting Conc. Barrier	L.F.	800-1,700	800-1,700
Guide Posts	Ea.	80-160	80-160
Paint Line	L. F.	14,000-100,000	60,000-211,000
Plastic Line	L.F.	400	2,200
Raised Pavement Marker	Hund.	8	18

Traffic Items

1. Allow time for forming and curing of concrete work.
2. Pavement marking production rates will decrease in channelization, intersection, and interchange areas.

SIGNAL/ILLUMINATION

Four pole signal intersection -	10-20 days
Illumination system -	5 days per pole
Would include the following work:	

Excavation, concrete, cure time, plumbing,
conduit and wiring.

Signal/Illumination Items

1. For material procurement use 4 months minimum.
2. These would be non-charged work days in most cases.
3. Revising/modifying existing system may warrant additional time.
4. Salvaging existing equipment may warrant additional time.
5. On projects where the electrical work is a small part of the overall work, it is doubtful that this work would be critical.

SIGNING

Sign Installation:

Sign Cantilever	2 days
Sign Bridge	5 days
Overhead Structure	2 days
Wood Posts	15/day
Metal Posts (concrete base)	4/day

Fabrication:

Signs	500 ft ² /day
Cantilever Structure	120 days
Sign Bridge Structure	120 days

Signing Items

1. Structure fabrication time includes approval of shop plans.
2. Fabrication of multiple structures would take less time.

OTHER ITEMS

Item	Units	Daily Production Rate (Based on 8 hour day)	
		West	East
Monument Case and Cover	Ea.	8	13
Conc. Slope Protection	S. Y.	100	100
Chain Link Fence	L. F.	250-700	250-700
Wire Fence			
Range	L. F.	550-3,600	550-3,600
Average	L. F.	1,600	1,600
Glare Screen			
Range	L. F.	100-1,000	300-1,900
Average	L. F.	350	1,100
Rock Protection Fence	L. F.	300	300
Gabion Cribbing			
Range	C.Y.	20-110	20-110
Average	C.Y.	40	40
Adjust Cone. Inlet	Ea.	4-11	4-11
Adj. Manhole	Ea.	8	8
Manhole Under 12 Ft.	Ea.	1.5	1.5
Manhole Over 12 Ft.	Ea.	1	1
Adjust Catch Basin	Ea.	4-12	4-12
Adjust Valve Box	Ea.	7-16	7-16

Other Items

1. Fencing production rates will vary with terrain, ground cover, and alignment.